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# ***JPRS Report***

# **Science & Technology**

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***USSR: Earth Sciences***

# Science & Technology

## USSR: Earth Sciences

JPRS-UES-89-004

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**'Trans-Arktika' Geophysical Studies Completed in Arctic Ocean**

18650185b Moscow IZVESTIYA in Russian  
19 May 89 p 4

[Article by V. Dvoretzkiy]

[Excerpt] A joint high altitude expedition of geologists, meteorologists and aviators which was the first of its kind has ended in the Arctic.

A new runway served for scarcely longer than a week. Before the last 60-ton AN-12 transport airplane departed, a movement of the ice began, and a piece of airfield the size of a soccer field broke off.

This expedition of polar geologists and scientists from Leningrad, meteorologists from Dickson and aviators from Krasnoyarsk proved to be unusually difficult. At the

beginning of March, they landed on ice beyond the 83rd parallel, at the very top of the earth.

Mikhail Yuryevich Sorokin, deputy head of the high-latitude expedition, told me: "In two months, geophysicists were able to study a section 500 kilometers long, running along a meridional traverse between the Lomonosov threshold and the Mendeleyev rise."

During the period of the drift, the expedition's ice floe moved 120 kilometers from the place where the first party of researchers was landed in March.

The airfield was relocated three times, and the runway had to be rebuilt three times.

All planned work in line with the "Trans-Arktika" program has been completed. The last personnel of the expedition returned to Leningrad at the beginning of the week.



**Possibility of Using Kola Superdeep Borehole in Seismology Noted**

18650180a Moscow PRAVDA in Russian 28 Apr 89 p 8

[Article by T. Romanovskaya, Moscow]

[Excerpt] The Kola superdeep borehole has been entered in the famous Guinness book of records. We asked Doctor of Geological and Mineralogical Sciences, Professor A. Krivtsov to comment on this event.

"The borehole is now 12,066 meters deep," said Anatoliy Ivanovich.

"The Kola superdeep borehole must be sunk to a depth of 13,500 meters by the end of 1990. It is proposed that the planned depth of 15,000 meters be reached in 1993. Sinking of the borehole may continue to deeper levels of the earth's crust, depending on rock and geological conditions at these depths. In the future, the borehole may be used as a geology laboratory—a deep-level underground observatory equipped with a string of various kinds of sensing devices which will monitor processes and pulses of the earth's crust in every layer that is revealed.

"Of course, proposals are now being heard that an underground satellite—a self-contained drilling rig—be launched from the greatest depths that the Kola borehole reaches. Development of such a rig will require new technologies.

"Study of deep levels of the earth's crust is important not only for geologists but also for scientists in other professional areas, since today's tectonic movements, earthquakes and centers of volcanic activity originate at precisely these levels, and strong flows of heat come from there. Many other phenomena, such as magnetism which affects people's life and activities, must be studied at deep levels of the earth."

FTD/SNAP

**Laser Deformograph May Be Used in Earthquake Forecasting**

18650180c Moscow PRAVDA in Russian 3 May 89 p 2

[Text] Preparations for experiments aimed at checking the general theory of relativity in terrestrial conditions with the aid of an optical clock have been in progress for a number of years under the direction of V. Chebotayev, corresponding member of the USSR Academy of Sciences, and Doctor of Physical-Mathematical Sciences S. Bagayev at the Institute of Thermal Physics of the academy's Siberian Branch.

Optical methods and laser equipment which have been developed in this connection make it possible to measure small deformation shifts of the earth's crust along large baselines. A test prototype of a laser deformograph which was developed at the institute has been installed in a gallery of the Baykal seismic zone.

The Siberian scientists think that the laser equipment which they have developed can be used in geophysics for the purpose of determining short-term precursor phenomena of earthquakes.

FTD/SNAP

**Can Lasers Predict Earthquakes?**

18650183a Moscow NOVOSTI PRESS AGENCY (APN) in English 25 Apr 89 p (2) - 1-2

[Text] Tatyna Dubnischcheva, Ph.D. (Phys. & Maths), in an article in NAUKA V SIBIRI, a scientific weekly published by the Siberian branch of the Soviet Academy of Sciences, has claimed that the laser systems developed at the Institute of Thermal Physics could register the heralds of earthquakes and therefore warn people about an imminent threat.

The system is based on two helium and neon lasers operating in different frequencies. The emission of the first laser is forwarded to the designated area, reflected, forwarded back, monitored and compared with the emission of the second laser. The fine measuring instruments are sensitive enough to monitor the slightest displacement of the object, even by a few hundredth fractions of a micrometer. One micrometer amounts to 1,000th of a millimetre. Such a tiny displacement was discovered on the curved line drawn by the instrument on the eve of the Armenian tragedy. The readings of the instrument subsequently registered the powerful peaks of the earthquake itself. When the scientists compared this anomaly, which happened on the eve of the earthquake, with other similar measurements, they arrived at the conclusion that their method offered an effective means to predict tremours. The Armenian quake, despite its disastrous consequences, helped the researchers find out that the deformograph could well be used for quake forecasting.

The physicists who have developed the laser-based measuring device are now certain that they can not only monitor the signs of an imminent quake in advance but also define the area and possible date.

To make the forecasting precise, laser deformographers must be properly located in seismically dangerous zones and combined into a network of quake predicting ranges. This may be a costly undertaking, but it certainly is worth it.

Novosibirsk.

(APN, April 21. In full.)

UDC 550.834.4:622.235

**Disturbances of Atmospheric Electrical Field in Near Zone of Underground Shot**

18650117 Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 3, Mar 89 (manuscript received 4 Jul 88) pp 51-59

[Article by V. V. Adushkin and S. P. Solovyev, Earth Physics Institute imeni O. Yu. Shmidt, USSR Academy of Sciences]

[Abstract] In the case of underground shots accompanied by the ejection of ground or a considerable deformation of the free surface, as well as the escape of gaseous

products of the shot and dust into the atmosphere, a low-frequency electrical field with a characteristic sign-variable form of change in strength with time is formed in the surface layer. The generation mechanism is governed by the processes of separation and relaxation of electrical charges due to the electrification of ground particles during intensive deformation and destruction under the influence of the compression wave and the expanding shot products. Negative electrical charges are accumulated on ground particles, whereas positive electrical charges are concentrated in the shot products. A simple spatial model of the distribution of electrical charges can be used for describing the changes in strength of the electrical field with distance from the shot epicenter. The maximal electrical charge in the atmosphere is formed during an underground shot at some optimal depth and is determined by the mass of the detonated explosive charge. Only ten-thousandths of a percent of the total energy of the charge is expended on formation of the electrical field in the ambient atmosphere. Figures 8; references 15: 13 Russian, 2 Western.

UDC 519.2:622.234

#### **State of the Art and Prospects for Underground Leaching of Metals From Surface by Borehole Systems**

18650118a Moscow IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: GEOLOGIYA I  
RAZVEDKA in Russian No 3, Mar 89 pp 102-106

[Article by L. I. Lunev, Moscow Geological Prospecting Institute imeni Sergo Ordzhonikidze]

[Abstract] Underground leaching is a method for selective reduction of a useful component into the liquid phase and subsequent reworking of the solutions containing metals (the most important being uranium and copper). The method makes possible more complete exploitation of underground ores whose extraction by traditional mining methods is unprofitable. This very brief state of the art review discusses the different borehole systems for the working of ore deposits used in the USSR, the various types of pipes, filters, pumps and other accessories employed. The main conditions for successful application of the different variants of the method are examined. Various timely problems in this field, requiring further development, particularly applicable to extraction of nonferrous, rare and precious metals from multicomponent solutions, are listed. The special methods needed for extraction of components from bedrock are considered, such as determination of the parameters of shooting work for producing artificial fracturing of the rock mass, research on different types of solid and liquid explosives for rock fragmentation. References: 5 Russian.

#### **Method for Registry of Temperature Field Variations in Regime Research for Earthquake Prediction**

18650158a Baku IZVESTIYA AKADEMII NAUK  
AZERBAJDZHANSKOY SSR: SERIYA NAUKI O  
ZEMLE in Russian No 4, Jul-Aug 89 pp 94-101

[Article by T. A. Ismail-Zade, G. A. Sarkisov, L. V. Yeliseyeva, F. G. Gadzhiev and N. S. Gasanov]

[Abstract] Within the seismogenic zones of the Greater Caucasus there are correlations between the nature of temperature variation of ground water and the seismic regime, making it possible to regard such variations as one of the informative precursors of earthquakes. In an investigation of temperature variations of ground water it is necessary to use a method for continuous registry of current temperature values or a method of discrete measurements at experimentally validated time intervals. A study of the temperature regime of different aquifers must be carried out using separate holes. The complexity and difficulty in organizing and carrying out long-term highly precise temperature measurements make it necessary to carry out many measurements in holes, such as temperature, fluid level and resistivity. Without increasing the cost of work, this makes possible a considerable increase in the volume of the collected data and considerably increases the accuracy and reliability of the seismic prediction. All such data must be processed using mini- or microcomputers using a program package for automatic recoding of the thermometric data and obtaining temperature values (TERM program), for constructing resultant curves of temperature change with time (GRAPH program) and histograms (GIST program) [block diagrams of the TERM and GRAPH programs accompany the text]. Figures 3; references: 6 Russian.

UDC 683.322:[550.4:550.343.37]

#### **Some Aspects of Development of Automated System for Earthquake Prediction**

18650158c Baku IZVESTIYA AKADEMII NAUK  
AZERBAJDZHANSKOY SSR: SERIYA NAUKI O  
ZEMLE in Russian No 4, Jul-Aug 89 pp 109-115

[Article by A. G. Gasanov, R. A. Keramova and Yu. Sh. Avshalumov]

[Abstract] The basis for an automatic system for earthquake prediction using geochemical precursors (AS/EP/GP) is described. The methodological aspects of construction of this system are outlined. Seismic prediction using geochemical precursors involves solution of both classification and identification problems, both of which are examined in detail. Earthquakes (seismically active zones) and the objects of observation must be combined into so-called type objects (homogeneous classes) using a set of criteria. In this part of the problem, using measurements of the geochemical components of fluids and earthquake parameters (magnitude, focal depth, epicenters) it is necessary to find the correspondence between a

seismically active zone (group of earthquakes) and the objects of observation (group of holes); there must be "referencing" of different earthquakes to specific objects of observation. The most informative set of seismogeochemical criteria must be chosen. Those parameters must be selected which correlate well with seismicity. A reduction in the number of criteria usually improves the quality of the prediction. The geochemical background must be determined and evaluated for the considered time period. Meteorological, physicochemical, seismic and other factors are involved in formation of this background. Seismogeochemical anomalies must be defined. The number of reference holes for the type object must be determined. The geographical coordinates of the object of observation must also be ascertained. Figures 2; references: 7 Russian.

UDC 550.34

**Prediction of Earthquake Focal Zones Using Seismic Data**

18650158b Baku IZVESTIYA AKADEMII NAUK  
AZERBAYDZHANSKOY SSR: SERIYA NAUKI O  
ZEMLE in Russian No 4, Jul-Aug 89 pp 102-108

[Article by M. M. Radzhabov]

[Abstract] Research in contrasting volumes of the Earth's crust with increased velocities reveals that strength of terrestrial matter favors the accumulation of elastic

stresses. The epicenters of possible earthquakes should therefore be concentrated within such volumes. Local contrasting crustal volumes identifiable with zones of anomalously increased or excess elastic stresses and responsible for focal zones of earthquakes are linked with regions of the existence of epicenters of microearthquakes. Their foci are localized at the same hypsometric levels as the volumes of anomalously excess stress. With these considerations taken into account, a model of the medium of formation of the focal zone of earthquakes was constructed which explains the interrelationship between the velocity parameters of the medium and seismicity indices. The model shows that the focal zone, characterized in space by a clustering of earthquake epicenters, stands out as a local volume which differs from the ambient medium in having definite physical properties. These properties are attributable primarily to the contrast of individual boundaries discriminated from local increases in the velocity parameters, correlating in depth and giving rise to a volume of the medium in which there is a higher strength, favoring an accumulation of excess stress. Within the limits of the considered territory such a volume is represented as a truncated cone, narrowing with depth, without inversions, with which regions of existence of epicenters of microearthquakes are also associated. Consistent data were obtained making possible an understanding of the main properties of the medium associated with the mechanics of earthquake preparation. Figures 2; references: 5 Russian.



### Microbes as Co-Makers of Earth's Climate

18650183c Moscow NOVOSTI PRESS AGENCY (APN)  
in English 25 Dec 88 pp (1) - 1-3

[Article by Georgy Zavarzin, corresponding member of the USSR Academy of Sciences]

[Text] The climate of the Earth will be changing. That was the conclusion formed by most of delegates attending a conference of the World Meteorological Organisation in Villach, Austria, late in 1985. Carbon dioxide and other greenhouse effect gases are now increasing in concentration in the atmosphere. And this, in the opinion of scientists, may lead to a substantial warming in the next century. Some of the greenhouse gases owe their origin to human economic activities. A major cause of the mounting greenhouse effect is carbon dioxide—the growth of its concentration by 0.4 per cent a year is an established fact, and the source is fossil fuels burnt in the furnaces of thermal power plants. There is also a growing concentration in the atmosphere of carbon monoxide. It is formed in internal combustion engines and in the air due to the photochemical oxidation of organic matter. Also, freon concentration grows by about 5 per cent annually.

At the same time it has been found in the recent period that methane and nitrogen monoxide—gases of bacterial origin—also increase their atmospheric concentrations each year—by 1-2 per cent and 0.2 per cent respectively. They, too, influence changes in the atmosphere's composition, perhaps entailing changes in the climate.

Concentration of gases in the atmosphere is the result of different processes. Gases enter and leave the atmosphere both because of reactions taking place in the atmosphere itself and because of interaction with the Earth's surface and the world oceans. In turn, such an emergence of gases is likewise the result of opposite biological reactions, for example, the absorption of carbon dioxide in photosynthesis and its release in respiration.

So, ground ecosystems are the source of greenhouse gases and the acting agents in them are microbial communities in conditions of excessive moisture. The respiration of the soil, its temperature and moisture have been found to be closely correlated with each other. Areas above which concentrations of carbon dioxide, methane and ethane are at their maximum, have characteristic soils with a high level of ground water. These soils lie on layers impervious to water—the permafrost or accumulative underlying horizons. Naturally, swamps and waterlogged soils are widespread here.

The total area of swamps with a peat layer more than 40 cm thick occupies some 150 million hectares on the Earth, with 40 million hectares in Western Siberia. Natural swamping has continued for several millennia, and the current annual growth of swampy territory in Siberia is some 10,000 hectares. The direct cause is

excessive free water, which raises the ground water level. Thus, formation of podzol and other soils of this type is one of the expressions of that same biological process which leads to the increased release of greenhouse gases.

Ecologists keep attaching great significance to the cutting out of tropical forests. But in the temperature zone felling is also intensive: in the US and the USSR it leaves more than 100,000 hectares of uncleared felling sites every year. In the vegetation period, felling drastically reduces the moisture transpiration and aeration of the topsoil, its respiration in felling increases by 100 times. All this leads to excessive humidification and creates favourable conditions for the development of an anaerobic microbial community. The northern zone, of all zones, finds itself connected with the increased production of greenhouse gases owing to unbalanced biological processes.

Intensive photosynthesis in the vegetation period predominates over the formation of carbon dioxide and lowers its content at higher latitudes. Summer rains facilitate the releases of nitrogen monoxide. Excessive moisture and soil washing contribute to the transfer of organic matter into the deeper layers. Early frosts stop the functioning of the bacterial "oxidative" filter, but gas generation continues until deep soil layers are frozen through. Excessive moisture, not balanced out by plant transpiration, maintains favourable conditions for the development of anaerobic processes involved in the production of methane.

Such is the supposed chain of events that govern the peculiar geographic distribution of greenhouse gases whose influence on the climate is so substantial. Ground ecosystems in the temperate latitudes of the Northern Hemisphere, where human economic activities are most intensive, prove to be extremely important for the planet's gaseous regime, which in turn is connected closely with the climate.

Most of the greenhouse gases have biological origin, and their content in the atmosphere reflects changes in the state of the ecosystems. The concentration of such gases has an uneven distribution both geographically and in time: gases build up over mid-latitudes of the Northern Hemisphere in the period when there is no photosynthesis. Since the maximum concentration of carbon dioxide, methane and ethane has been found over the zone of the tundra and northern forests, their sources are microbiological processes in soils. Consequently, the reason why the greenhouse gases change their concentration is the increased activity of anaerobic microbial communities.

Why then has insufficient attention been paid to the soil community in this respect? The point is that researchers were mostly interested in the removal of carbon dioxide in the photosynthesis process and the role of the vegetative cover. The dynamics of decomposition of organic matter was not given sufficient significance, although in

energy terms this process is close to photosynthesis. Also, attention was focused on mean global assessments of gas concentration changes, which prevented finding specific systems responsible for them. The last reason is the gap between the specifically biological and especially microbiological approach, confined to studying bacteria in a few cubic centimetres or decimetres of a sample, and the global assessment of the state of the atmosphere as a whole. Yet it turns out that by knowing even the balance of microbial activity in a specific landscape, one can go over to global assessments. But, unfortunately, there is no such integral approach in microbiology. Incidentally, biogenic gases, and, given enhanced sensitivity, also biogenic organic substances, do contain information on biological processes, from which one can have a general evaluation of the activity of the microbial community.

The composition of the atmosphere reflects in the most general form the changes taking place on the Earth. Winds that can carry gaseous admixtures know of no boundaries and it is natural that the chemistry of the atmosphere has become the object of international studies, and the atmosphere is closely linked with the climate. The atmospheric composition, climate and biosphere have numerous feedbacks, which can be understood only in interdisciplinary investigations. The current changes are slow, but, as studies have shown, they must be taken into account in long-term planning of human activities. We are now trying to understand the actual causes of ongoing changes and to predict their possible course in order to forecast economic development. (APN)

### Climate Shaped in the Depths of the Earth?

18650183d Moscow NOVOSTI PRESS AGENCY (APN)  
in English 25 Dec 88 pp (2) - 1-4

[Article by Ivetta Useinova]

[Text] How can it be explained that over the past million years vast territories of Eurasia and North America were repeatedly covered by three-kilometre-thick ice blankets which then for some reason receded and melted away? To this day this question remains one of nature's main mysteries. Since the middle of the last century when the Swiss naturalist J.-L. Agassiz first proved the existence of glacial epochs on Earth, there have been some 200 theories trying to explain that weird phenomenon in the evolution of the planet. What's more, each hypothesis relied on one sole cause of the glaciation.

So who is right in this century-long scientific dispute? Two Leningrad oceanologists, Dmitri Chalikov and Mikhail Verbitski, have set out to resolve it, choosing dispassionate computers for arbiters.

Having built their own physico-mathematical model of the global climate, the two boffins fed through a computer all the "scenarios" which are supposed to have unfolded on the planet during the Ice Ages. The result

proved quite unexpected: having analyzed all the existing glaciation theories, the computers came up with their own interpretation of the climatic vicissitudes of the past.

Large-scale climatic changes of the type of glacial periods depend on a factor which was formerly almost totally ignored by researchers: geotectonic processes. Such is the main conclusion of the computers, on which basis the two Leningrad researchers are now building a new scientific version about the causes of the onset of glaciers. They insist that global climate formation and evolution happen as a result not only of the interaction of the atmosphere, the oceans and the glaciers as is traditionally believed, but also of the direct participation of another natural element, the asthenosphere, which is a special stratum in the upper mantle of the Earth. The extreme inertia of the processes in that stratum is offered by the Leningrad researchers as an explanation for one of the most disputed "irregularities" or rather regularities of the Ice Ages: their occurrence at regular intervals of 100,000 years. It has been proven now that this is exactly the interval at which glacial periods have set in and receded in the Pleistocene epoch over the past million years.

Can climatology and geotectonics really run in the same scientific harness? Is the answer to the climatic secrets really hidden in subterranean depths? I addressed these questions to Mikhail Verbitsky [as published] and received an answer in an unusual form: a cup of tea with a slice of lemon.

"Imagine that this is a continental plate," said Verbitsky, pointing to the floating slice, "while the tea is the asthenosphere or that viscid stratum in the mantle on the surface of which the continents are believed to be moving. Let's do a small experiment," the scientist continued putting our tea-for-two on a scientific basis, "watch what happens when I pour sugar on the lemon..."

The experiment did not produce any surprise: the yellow ring behaved as it normally does in such cases—first it sank into the tea under weight of the sugar and then, having freed itself of the dissolved sugar, made it to the surface again.

I was told that one can assume that the Earth's crust under the burden of glaciers behaves in approximately the same way as the sugar-loaded slice of lemon: it sinks into the asthenosphere and then surfaces again when the ice melts down. Such a process is happening in Europe now in the area once occupied by the Scandinavian Ice Shield, which covered a considerable part of the continent about 20,000 years ago. It has been calculated that due to its release from the glacier's burden the land surface in that area has already risen up 275 metres and keeps rising.

In drifting about the viscid asthenosphere, the continents are believed to be able to rise and sink like an elevator under the impact of ice. The amplitude of such oscillations can amount to a third of the thickness of the ice cover and last a total of 100,000 years.

This is precisely the phenomenon in which the Leningrad researchers think they have detected a direct relationship between climatology and global tectonics of the lithospheric plates. They insist that this dependence is clearly traceable on another, still larger, time scale of the approximately 100 million years over which the planet has undergone not just fluctuations but cardinal changes in the climate. They are said to be linked with the changes in the location and configuration of the continents, which were caused by their horizontal drift. That "retailoring" of the continents and the oceans must have brought about radical changes in the ocean water circulation and atmospheric currents which serve as a kind of air and water heating system for the planet.

"In our studies," says Verbitski, "we have come to the definite conclusion that the nature of the climate on the planet, its changes and regular fluctuations depend mostly on one exclusively geographic factor: global distribution of land and sea."

So what has prompted the two men to add a fundamentally new "part", the asthenosphere, to the well-known design of the climate "machine" consisting of three basic "units"—the atmosphere, the oceans and the continental glaciers?

"This fourth element in our model of the global climate," replies Mikhail Verbitski, "has appeared as a result of the search for answers to a whole 'package of questions' [quotation marks as published] which are probably the most intriguing of all in the mystery of the glacial epochs. Why, for example, has the degradation of the glacial shields happened so fast—on the geological time scale, that is? There is also a striking difference in the speed of the advance of the glaciers and of their retreat: the former took tens of thousands of years, while the latter happened dozens of times faster. Specifically, the last glaciation and the attendant cooling-off lasted a total of 60,000 years, while the total decay of the glaciers, which had crept down to Kiev latitudes, happened in just 5,000 years.

So what has sped up the degradation of the glaciers, thereby bringing closer the end of the global "cold spell"? Colossal amounts of energy were needed for that, thousands of times greater than those which exist in the atmosphere. It obviously was not the only source of heat capable of warming up glaciers which were many times larger than the modern Antarctic and Greenland ice shields. So from where did nature pump the needed energy? There is only one source of heat on the planet

where it is in excess: the oceans. But then how could that "ocean fuel" get used in such great amounts for the heating of the continental glaciers? While looking for a possible "energy bridge" by which the oceans could deliver their heat to the glaciers, the Leningrad oceanologists made an interesting discovery which fits into the sacramental phrase about Mahomed and the mountain. The scientists have figured out with the help of computers that it was not the ocean heat that came to Mahomed, that is the glaciers, but the other way round. The delivery vehicle was the asthenosphere.

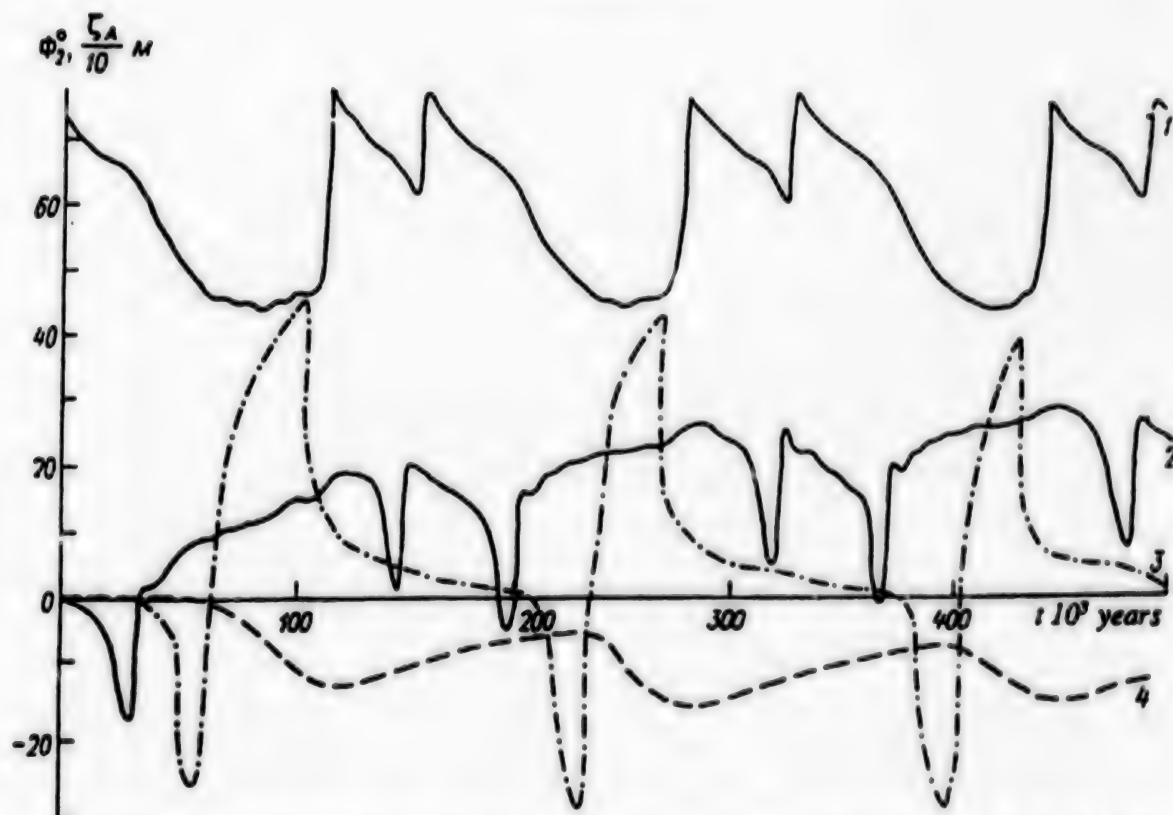
So how do the authors of the new glaciation theory think that mechanism works in the climate machine? Presumably as follows: when sections of the earth's crust sink into the asthenosphere under the burden of glaciers, this eventually creates the conditions in which that vertical transporter "takes down" the glaciers themselves, with their foundation ending up below sea level. As a result, huge ice masses creep over from the continents onto the extensive shelf, the ice floats up, disintegrates into icebergs and melts up in the warm ocean waters. Evidence has been found now that the destruction of the St. Lawrence Ice Shield which covered almost the whole of North America 20,000 years ago happened exactly that way. It was such direct contact with sea water, insist the authors of the new hypothesis, that contributed to the rapid disappearance of the continental ice-fields, whereupon the climate of the planet moderated once again.

Preconditions for major climate changes of the type of glacial periods may come and go with the horizontal drift of the continents and the attendant evolution of the terrain. This is another conclusion to which the Leningrad oceanologists were led by their studies. This makes it clear now why the periods of global glaciation happened only in specific epochs. In the history of the Earth they are recorded only in the Precambrian and Paleozoic eras and in the Pleistocene period. At those moments the conditions on the planet met the three requirements which the Leningrad scientists insist are mandatory for the occurrence of glacial periods.

Here are those three requirements as elaborated by computers. First, a certain location of the continents under which they should extend sufficiently far into the temperate latitudes—the way the Eurasian and North American continents are now situated. The second condition is mountainous terrain in high latitudes. Computer experiments prove that the initial formation of a glacial shield can only occur in mountainous regions which serve as a kind of kitchen for glaciers. Sliding down from the mountains like porridge boiling over, the huge ice masses, which acquire flexibility, reach deep into the continents, gradually filling up the valleys. In our geological epoch such a mountainous terrain exists in Scandinavia.



# Glacial Periods



Key:—1. Northern iceshield spread limits ( $\Phi_2$ )—2, 3, 4. Free asthenosphere surface evolution ( $\zeta$ ) for 62.5, 47.5 and 32.5 N. Lat., respectively.

The most momentous climatic changes happen when big continents with mountainous regions at their upper edges are covered mostly by plains on the rest of their territory. This is the third and final condition. The mountains where the embryos of future glaciers gestate

must not serve as a barrier to their inward advance and, at the same time, must not prevent the sinking of the continent edges with their load of ice below sea level. In other words, terrain serves as a regulator of the beginning and the end of glacial periods. (APN)

**Submarine-Disaster Area To Be Studied From Research Ship 'Keldysh'**

18650180d Moscow SOVETSKAYA ROSSIYA  
in Russian 4 May 89 p 4

[Text] As has been reported in the press, routine monitoring of radiological conditions is in progress in the area of the Norwegian Sea where a Soviet submarine was wrecked. Results of this monitoring have aroused no concern. However, the USSR Academy of Sciences plans to begin a comprehensive oceanologic examination of the area from the scientific research vessel "Akademik Mstislav Keldysh" in the middle of May, for the purpose of inspecting the ecological situation more extensively and comprehensively.

The Soviet and international publics will be informed regularly on results of these studies.

FTD/SNAP

**Tests of Modernized Submersible Craft During Cruise of Ship 'Keldysh'**

18650181b Frunze SOVETSKAYA KIRGIZIYA  
in Russian 23 Apr 89 p 4

[Text] The USSR Academy of Sciences' scientific research vessel "Akademik Mstislav Keldysh" has completed its 17th cruise, during which the latest trials were conducted of new deep-diving manned craft which had been repaired and modernized recently at a West German firm. The craft were subjected to rigorous tests in the weather and temperature conditions of the Atlantic Ocean.

The new craft have a number of advantages over similar ones, such as France's "Nautilus" and the U.S. "Seacraft." Their main advantage is their maximum diving depth, which is in the 6,000-meter range. Almost 99 percent of the area of the world's oceans is at such depths. More than 20 parameters of water and sedimentary rocks can be studied with the aid of the new craft. Samples can be taken with special manipulators, video and motion-picture photography can be done, and underwater drilling and other operations can be performed.

(A photograph is given showing a submersible craft suspended above the water from a hoisting device.)

FTD/SNAP

**Research Vessels Monitor Radiation in Area of Submarine Disaster**

18650182a Moscow KRASNAYA ZVEZDA in Russian  
11 May 89 p 1

[Excerpt] Background radiation in the place where a Soviet nuclear-powered submarine was lost in the Norwegian Sea remains at the former level, which does not exceed the natural level. This is the conclusion drawn by

participants of a special expedition which has returned on board the scientific research vessel "Vsevolod Berezkin" to Murmansk from the disaster area.

"Our specialists have been monitoring the radiation condition of the environment since the first day after the accident," said P. Vlasenko, head of the Murmansk Territorial Administration for Hydrometeorology and Monitoring of the Natural Environment. "Such monitoring was done first by a team of the scientific research icebreaker 'Otto Schmidt,' which was closer than others to the place of the incident. The motor ship 'Vsevolod Berezkin' then went out to sea with a set of special equipment and highly experienced specialists on board. Samples of water taken from the surface of the sea and at various depths were subjected to careful analysis, as were samples of ground from the seabed. Results of these analyses indicate that there is no radiocontamination of the sea. This is confirmed by information that the submarine's reactor is shut down reliably."

Hydrometeorologists of the polar region have decided to examine the environment in this area of the Norwegian Sea at least once every 3 months.

FTD/SNAP

**Expedition Sent To Locate and Examine Sunken Nuclear Submarine**

18650182b Moscow KRASNAYA ZVEZDA in Russian  
12 May 89 p 1

[Excerpt] A group of vessels is setting out for the area of the Norwegian Sea where the Soviet submarine "Komsomolets" was lost, in order to determine this submarine's precise location and examine it. A KRASNAYA ZVEZDA correspondent met with Captain 1st Rank A. Zakharov, head of the Northern Fleet's search-and-rescue service, and asked him to answer some questions.

"The group of vessels includes the 'Georgiy Titov' and 'Mikhail Rudnitskiy,' rescue ships of the Northern and Black Sea fleets, respectively; the 'Persey,' a hydrographic vessel of the Leningrad Naval Base; and the 'Akademik Mstislav Keldysh,' a scientific research vessel of the USSR Academy of Sciences," said A. Zakharov. "Rear Admiral Yuriy Ivanovich Boyarkin heads the group."

"Anatoliy Vladimirovich, what specifically are the tasks that this impressive party of special vessels faces?"

"The hydrographic vessel 'Persey' is supposed to be the first to arrive at the place where the submarine sank. It is to mark off the search area and define its limits. It will then begin searching for the submarine with the aid of onboard equipment. This search will take several days, depending on the weather."



"Unmanned submersible craft carried on board the rescue vessel 'Georgiy Titov' will then be enlisted in the operation. If contact is established, an attempt will be made to photograph the object of contact. As soon as the submarine is discovered, manned submersibles will examine and photograph it. The submarine's condition will be analyzed in the cruise headquarters, and conclusions as to the possible causes of the wreck will be drawn when sufficient data are available.

"Two 'Pisces' manned submersible craft (diving depth—up to 2,000 meters) will be on board the rescue vessel 'Georgiy Titov.' These craft were purchased abroad at one time for scientific research purposes. A transport airplane will deliver them from Kaliningrad. The 'Akademik Mstislav Keldysh' has two manned submersibles: the 'Mir-1' with a diving depth of up to 6,000 meters, and the 'Mir-2.' The rescue vessel 'Mikhail Rudnitskiy' is equipped with a 'Poisk-2' craft. All of the submersible craft carry three-man crews."

FTD/SNAP

UDC 534.21

**Dislocations of Phase Front in Oceanic Wave Guide and Their Manifestation in Acoustic Measurements**

18650115a Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 35 No 2, Mar-Apr 89 (manuscript  
received 26 May 88) pp 260-265

[Article by V. A. Zhuravlev, I. K. Kobozev and Yu. A. Kravtsov, General Physics Institute, USSR Academy of Sciences]

[Abstract] Research on phase front dislocations in oceanic wave guides is important because the position of the field zeros makes possible a qualitative understanding of the behavior of the field phase as a function of coordinates in the entire considered region. The presence of field zeros and phase front dislocations must be taken into account when interpreting the results of phase measurements in experiments with acoustic sounding of the ocean because the phase gradient of the total field in the neighborhood of dislocations is substantially greater than in other parts of the wave guide and the phase gradient field tends to infinity directly at the point of a zero field. A study was made of the generation of phase front dislocations in a wave guide with a small number of modes. It is demonstrated that the distribution of dislocations in the wave guide section is nonuniform. The movement of dislocations caused by a tide is examined and a numerical example is used in illustrating the nature of change in the field phase with the passage of dislocations near the receiving antenna. In multimode wave guides the existence of field interference zeros and phase front dislocations is probably the rule rather than the exception (a formula is derived for determining the density of dislocations). Figures 5; references 6: 4 Russian, 2 Western.

UDC 534.222

**Model Investigations of Modal Structure of Field of Parametric Radiator in Acoustic Wave Guide**  
18650115b Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 35 No 2, Mar-Apr 89 (manuscript  
received 22 Mar 88) pp 266-271

[Article by V. Yu. Zaytsev, V. V. Kurin and A. M. Sutin, Applied Physics Institute, USSR Academy of Sciences; Gorkiy State University imeni N. I. Lobacheskiy]

[Abstract] An experimental study of the modal structure of the field of a parametric radiator in an acoustic wave guide was made. Time selection was used for discriminating individual modes. The radiated pulsed signal, due to intermode dispersion, decayed into a number of pulses, each of which corresponded to its wave guide mode. This analysis method made it possible to investigate the modal structure of the radiated field, to determine the dependence of the intensity of radiation on wave guide depth, the conditions for the optimal excitation of individual modes and the angular distribution of the fields in different modes. The model developed by V. Yu. Zaytsev, et al. (AKUST. ZHURN., Vol 33, No 1, pp 37-42, 1987) was used in a theoretical description of the observed effects. The measurements were made in a regime of traveling waves in a flume with a width 0.7 m and a length 6 m with a depth of the water layer varying in the range 35-200 mm. It is shown that the excitation of definite wave guide modes is possible using a parametric radiator. An optimal angle of inclination of the radiator exists for each of these modes. Due to the difference in the angular structure of the modes, for a multimode signal the angular distribution of field level is dependent on the depth of positioning of the receiver and its distance from the source. The use of the mentioned model made it possible to explain the fundamental laws of field formation and to obtain a fairly good quantitative agreement between the experimental results and computations. Figures 4; references 10: 9 Russian, 1 Western.

UDC 534.2

**Spatial Distribution of Field in Neighborhood of Caustic Forming During Sound Scattering by Vortex Velocity Field**

18650115c Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 35 No 2, Mar-Apr 89 (manuscript  
received 19 Jan 88) pp 277-284

[Article by V. V. Klimov]

[Abstract] The influence of vortices on sound scattering is governed by two mechanisms. The first is the mechanism of scattering on inhomogeneities of the refractive index and the second is scattering on the vortex velocity field. The results of solution of the model problem of sound scattering by the velocity field of an axisymmetric vortex with spatially limited vorticity are presented. The

problem is solved using a method similar to the phase screen method and an attempt is made to describe the field after scattering on a Hill vortex, also correct in the neighborhood of a caustic. The basis for the proposed approach is the fact that immediately after the vortex the field is correctly described by the geometrical acoustics approximation and that outside the vortex core the field satisfies the Helmholtz equation. Taken together these facts make it possible to determine the field in the entire half-space behind the Hill vortex. The results are represented in asymptotic and graphic forms. In full accordance with an analysis in the modified geometrical acoustics approximation, the Hill vortex, oriented along the wave vector of the incident wave, has focusing properties. A relatively simple solution of the problem can be found due to spatial limitation of the vorticity region. The proposed method can therefore be easily extended to other axisymmetric vortices with spatially limited vorticity, such as to Kelvin vortices. Figures 5; references 10: 9 Russian, 1 Western.

UDC 534.222

#### **Dynamics of Hydrostructures in Field of Acoustic Wave**

18650115d Moscow *AKUSTICHESKIY ZHURNAL*  
in Russian Vol 35 No 2, Mar-Apr 89 (manuscript  
received 23 May 88) pp 327-332

[Article by M. Yu. Romanovskiy, General Physics Institute, USSR Academy of Sciences]

[Abstract] A study was made of "self-clearing" fluids in which the coefficient of sound absorption decreases in amplitude and sound penetrates farther into the fluid under the influence of an acoustic field. An analysis was made of the physical mechanisms involved and the classes of substances in which the appearance of such hydrostructures is possible are discussed, followed by a determination of the values characterizing their propagation. It is shown that several types of structures can be maintained in an ultrasonic beam with a power of several watts. First, a thermal wave of acoustic "clearing" is possible in highly viscous fluids of the glycerin type with a considerable temperature dispersion of viscosity. Second, in non-Newtonian fluids with rheologies not dependent on time the developing regions of fusion may be propagated in the hardening matter. Third, there may also be movement of vortices, existing in a Newtonian medium, interacting with an acoustic beam. The developed theory makes it possible to estimate the velocity of propagation of these structures, for which there is usually a lower limit. Their velocity of propagation in an ultrasonic beam with a power of several watts is fractions of a cm/s. References 20: 18 Russian, 2 Western.

#### **Evaluation of Possibilities of Search for Massive Sulfides and Mapping of Rocks on Ocean Floor by Transient Processes Method**

18650118b Moscow *IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: GEOLOGIYA I  
RAZVEDKA* in Russian No 3, Mar 89 pp 116-118

[Article by F. M. Kamenetskiy, P. V. Novikov and A. I. Nikonov, Moscow Geological Prospecting Institute imeni Sergo Ordzhonikidze]

[Abstract] One of the timely problems in modern geology and exploration for minerals in the world ocean is the search for massive sulfide ores. One of the criteria used in such exploration and mapping is the differentiation of rocks and ores on the basis of conductivity. This provides a basis for the use of electromagnetic methods, including transient field methods, which have recommended themselves well in the solution of similar problems on the land, or sounding by the method of field formation in the near zone. Since such research is carried out at relatively great depths (2-3 km), one of the most effective methods is a near-zone apparatus towed by a submersible. Then the conditions for use of these methods differ from surface use primarily by replacement of the upper nonconducting half-space by a well-conducting half-space. This difference is so substantial that it is first necessary to make a theoretical evaluation of the influence of the lower half-space against a background of a strong signal from eddy currents in the upper half-space. This is illustrated in a specific example. It is shown that the mapping of sea floor rocks on the basis of their resistivity is possible beginning with a few ohm x m. This is a favorable circumstance in exploration for massive sulfide ores whose resistivity is usually less than 1 ohm x m. Also examined is the special case when the massive ore does not make up the entire lower half-space, but only a small part of it. The character and intensity of the signal shaped during such soundings are discussed. The mapping of low-impedance rocks of the ocean floor and the search for massive sulfide ores is therefore possible by the transient processes method using a near-zone apparatus in the form of matched or coaxial loops towed by a submersible. Figure 1; references: 2 Russian.

UDC 552.124.4:553.32.31:551.3.051

#### **Sedimentation Rates and Growth of Ferromanganese Nodules in Pacific Ocean**

18650173a Novosibirsk *TIKHOOKEANSKAYA  
GEOLOGIYA* in Russian No 2, Mar-Apr 89  
(manuscript received 9 Dec 87) pp 3-13

[Article by S. I. Andreyev, T. I. Linkova, L. I. Anikeyeva, A. N. Kulikov and Yu. Yu. Ivanov, Sevmorgeologiya Geological Production Association, Leningrad; North-eastern Multidiscipline Scientific Research Institute, Magadan]

[Abstract] Despite a number of assumptions, radiological and paleomagnetic methods make possible a reliable determination of the relative rates of growth of ferromanganese nodules and sedimentation. The optimal rate

of sedimentation for the formation of nodules varies from one oceanic structure to another. For example, in the Clarion-Clipperton region this process transpires most extensively with a sedimentation rate averaging 3 mm per thousand years and attenuates with an increase or decrease in the sedimentation rate, whereas in the Peruvian Basin the rate of sedimentation in nodule regions is 4-5 mm per thousand years. Among the geochemical types of nodules the most rapid growth is observed for rich nickel-copper ore nodules, in whose formation an important role is played by the early diagenesis of bottom sediments. The slowest growth is for cobalt-rich nodular formations of predominantly hydrogenic genesis. The process of formation of nodules in some oceanic regions might have been multistage. This is reflected in the different magnetization of nodules and is confirmed by finds of more ancient nodules in the nuclei of younger nodules. The growth of Fe-Mn nodules is a nonuniform process. In nickel-copper nodules, due to the diagenetic supply of material, the lower parts grow more rapidly than the upper parts by a factor of 1.3-1.7. The opposite is observed for encrustations rich in cobalt: due to the hydrogenic supply of material the encrustations forming on the upper surfaces of the blocks grow more rapidly than those forming on the lower surfaces. Figures 4; references 28: 15 Russian, 13 Western.

UDC 550.344.094.43

#### **Sound-Scattering Effect of Bottom Water in Marginal Parts of Sea of Okhotsk**

18650173b TIKHOOKEANSKAYA GEOLOGIYA  
in Russian No 2, Mar-Apr 89 (manuscript received  
12 May 86) pp 119-121

[Article by A. I. Obzhirov, B. A. Kazanskiy and Yu. I. Melnichenko, Pacific Ocean Oceanology Institute, Far Eastern Department, USSR Academy of Sciences, Vladivostok]

[Abstract] During the 7th cruise of the "Akademik Aleksandr Nesmeyanov" a study was made of the gas component of bottom water in some parts of the Sea of Okhotsk and the possibility of using the natural gas in bottom water as an indicator in search for oil and gas deposits and in the mapping of fault zones was investigated. The survey was made along profiles across the strike of the main geological structures. Echo sounding was carried out while the ship was proceeding on course and samples of bottom water were taken at stations using bathometers. Two sectors were found with sound scattering on bottom water, registered on echograms in the form of vertical "columns." In the western part of the Sea of Okhotsk the observed columns contained increased methane contents exceeding the background levels by a factor of 50. In the southeastern part of the sea the concentration of methane and other gases in the columns did not exceed the background by a factor greater than 2. The acoustic basement in this region is covered by Miocene-Pliocene sandy-clayey deposits with

a thickness as great as 6-8 km in basins and having a significant oil and gas potential. The methane, forming in rocks due to thermogenic transformation of buried organic matter, migrates upward along fissures and faults, penetrating into the bottom water layers and causing sound scattering effects recorded on echograms. The area is characterized by high recent tectonic activity with good prospects for finding gas and oil in the sedimentary mantle. References 5: 4 Russian, 1 Western.

UDC 551.465.11

#### **Dynamic Interaction Between Field of Current Velocity and Inertial Velocity Fluctuations in Ocean**

18650129e Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 25 No 3, Mar 89 (manuscript received 23 Feb 88,  
after revision 7 Jun 88) pp 312-317

[Article by L. M. Fomin, N. N. Kolchitskiy and A. D. Yampolskiy, Oceanology Institute, USSR Academy of Sciences]

[Abstract] A model of inertial fluctuations in the velocity field of currents is proposed. It is assumed that current velocity and pressure do not vary in space and time at the scales of inertial movement. Averaged equations are derived with terms for the Reynolds stresses generated by fluctuations of horizontal velocity at an inertial frequency. The stresses reduce the contribution of the Earth's rotation and the balance of momentum, but in the equation for conservation of vorticity of the current velocity field they reduce the  $\beta$  effect and horizontal velocity divergence. Quantitatively these effects are dependent on the ratio of the energy of the inertial velocity wave to the kinetic energy of the current. The inertial velocity fluctuations may play an important role in the internal dynamics of the ocean. They are formed against a background of larger-scale currents and their parameters are determined by the structure of the current velocity field. They exert an influence on the dynamic balance in the field of currents. It appears that models of the local dynamics of synoptic eddies and eddy-resolving models of the ocean must take into account the mechanism of interaction with inertial fluctuations. Although the estimates indicate the importance of this mechanism, they were based on a simplified model of inertial fluctuations and additional research is therefore required. Figures 2; references 9: 7 Russian, 2 Western.

UDC 551.467

#### **Features of Radiothermal Radiation of Fresh-Water Ice Cover With Transitional Layer at Water-Ice Interface**

18650169d Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 25 No 4, Apr 89 (manuscript received 4 Jan 88,  
after revision 31 Aug 88) pp 396-401

[Article by G. S. Bordonskiy, S. D. Krylov and S. V. Polyakov, Chita Institute of Natural Resources, Siberian Department, USSR Academy of Sciences]

[Abstract] A study was made of the radiothermal radiation of an ice-water system with the formation of a

transition layer at the interface consisting of a mixture of gas and water, such as is often observed in natural fresh-water water bodies. Gas inclusions exert an influence on the intensity of radiothermal radiation of the ice cover. These inclusions appear in the ice during the crystallization of water from dissolved gases and due to the release of gases in processes of decomposition of organic substances in bottom deposits. Radiobrightness temperature decreases when there is a homogeneous distribution of gas inclusions in the ice. With the occurrence of scattering on spherical gas bubbles in ice with thicknesses less than one meter there is an increase in the intensity of radiothermal radiation. However, for a

fresh-water ice cover there is another form of behavior of the radiation coefficient when the radiobrightness temperature increases when gas bubbles are present in the system. This is associated with the accumulation of bubbles at the ice-water interface when there is gas release from the bottom. The transition layer can result in an increase in radiobrightness temperature up to tens of degrees Kelvin. Measurements of the ice cover on lakes in Chita Oblast at wavelengths 0.8-3 cm indicated increases in radiobrightness temperature of 5-10 K. The findings are of interest for solving problems in limnology and ecology. Figures 3; references 11: 7 Russian, 4 Western.



### Scientific Participants in Aerial Studies of Arctic Ozone Layer

18650181a Moscow NTR: *PROBLEMY I RESHENIYA* in Russian No 4, Apr 89 p 1

[Excerpt] The first group of specialists of the USSR State Committee on Hydrometeorology's Central Aerological Observatory has returned from a high-latitude Arctic expedition. From an airplane, they sought an answer to the question of whether "ozone holes" exist over the Arctic. Our special correspondent Yelena Druzhinina was on flights with these specialists. She relates:

"Three weeks ago, we set out from Sheremetyevo for the Far North. Our IL-18 airplane was specially equipped for research of the atmosphere. At the controls of the 'Tsiklon' were V. N. Kotovich and O. L. Nazarov, two experienced test-pilots. Experiments were organized not on the ground but in the air, at altitudes of 8,000-10,000 meters.

"The airplane's set of instruments was in the hands of experienced specialists. Candidate of Physical-Chemical Sciences A. Ye. Tyabotov's group operated a lidar instrument which scans stratospheric clouds, and S. N. Skuratov operated spectrometers. V. G. Anosov, an associate of the Main Geophysical Observatory imeni Voyeykov and the only Leningrader among the group from Moscow, was engrossed in ozonometry. Candidate of Chemical Sciences Yu. L. Tolchinskiy collected samples of outside air in capsules."

FTD/SNAP

### Solid Gas in Ozone Holes?

18650183b Moscow NOVOSTI PRESS AGENCY (APN) in English 10 Feb 89 pp (2) - 1-3

[Article by Vladimir Tsarev, doctor of chemistry, deputy director of the Institute of the Development of the North, USSR Academy of Sciences; first paragraph is NOVOSTI PRESS AGENCY (APN) introduction]

[Text] Several years ago the world heard about the Soviet discovery of massive deposits of natural gas found in an unusual, solid, state in Siberia and on the seabed. It has been supposed recently that such gas can also occur in the stratosphere and trigger the alarming deterioration in the ozone layer. This hypothesis is explained by one of its authors Vladimir Tsarev, Doctor of Chemistry, deputy director of the Institute of the Development of the North, Academy of Sciences of the USSR.

### Those Hapless Freons

The falling ozone concentrations in the atmosphere in recent years indubitably threaten the world's ecology. We have not yet fully realised the dangers of this perplexing phenomenon.

It is worth remembering that the ozonosphere, which consists of triatomic oxygen molecules, is a layer with its base at 10 km, top at 50 km and maximal concentrations at 20-25 km above the Earth. We all know that ozone shields living organisms from harmful hard ultraviolet radiation of the Sun, absorbing its radiant energy and thus heating the stratosphere, ozone prevents surplus heating of the lower, ground air layers. In fact, ozone is the heat insulation of our planet. As the ozone layer disintegrates, Earth's surface begins to warm up, which can be compared with the known greenhouse effect due to carbon dioxide industrial exhausts. You can foresee its results—a rising world ocean level, widespread floods, advance of the desert and falling harvests.

Alas, we don't know yet the mechanism of this global phenomenon. Two groups of hypotheses have been advanced to explain it. The first one links ozone depletion with natural processes, and the second one with technology. The strongest accusation against industry is the discovery of freons and the directly related chemical compounds in the lower stratosphere. Under the impact of solar radiation these substances react with ozone, converting it into ordinary oxygen and other components.

It might appear, then, that freons are the villain of the piece. But, chemical reactions which disintegrate ozone have proved to be extremely improbable in the stratosphere because of the reactants' very low concentrations and the extremely low temperatures. For even colliding molecules they raise almost insuperable energy barriers.

American researchers have added a nice aspect to the initial hypothesis: reactions of the required intensity are possible on the surface of the ice particles which form Polar stratospheric clouds. Further research again showed an inconsistency with the reactants' concentration: for such a process in the ozone layer much more moisture is required than is obtainable.

### The Mysterious Collaborator

So maybe it's not freons that are consuming the ozone? Yes, it is, but how? Assuming that ozone depletion is caused by technology, we decided that freons must have a treacherous ally, aggressive and capable of seizing molecules which drift in the rarefied stratosphere, making them clash and combine in defiance of all energy barriers.

This role appears to be played by clathrate hydrates—solid gas-water compounds which Soviet scientists discovered in the Earth's depths. It is clear now they can also emerge periodically in the ozone layer.

Essentially, gas hydrates are compounds resembling porous ice in spring. Their crystal lattice, formed by water molecules, has larger cavities in comparison with usual ice, which trap gas molecules. Hydrates are widespread. They are found, besides on the Earth crust, in



world ocean sedimentation, where the temperatures are low and pressures high. It is supposed that hydrates form the silver clouds in the mesosphere and are found in cometary nuclei and on Mars.

In the upper atmosphere hydrate crystals concentrate reactants. Gas molecules in them are securely kept in the ice trap. One volume of hydrates contains up to 150 volumes of gas hydrate producers, which explains the issue of reactant concentrations in the stratosphere.

This also explains why cold and the energy barriers do not exist for chemical reactions up there. Experiments which we and foreign researchers have staged show that, when crystals emerge, a surplus potential of up to 300 volts appears on their solid surface, which is more than enough to overcome the high energy barriers in the reacting substances' molecules. This paves the road for ozone disintegration.

It has been noticed that the ozone layer is thinning in mostly the high latitudes—above the North and South poles. This is traditionally explained by the movement of air masses and their global circulation. I can add that the conditions for hydrate formation there are most favourable: the atmosphere is frozen during the long Polar nights.

#### Are We Near the Point of No Return?

The authors of this hypothesis are often asked, "supposing your idea of the disintegration mechanism of the ozonosphere proves right, will it be possible to slow down, or even stop this dangerous process?" For that the international agreements have to be strictly observed and industrial emissions of potential hydrate producers into the atmosphere sharply cut.

As you know, water is a must in hydrates. Much of it gets into the stratosphere from the exhaust of high-altitude planes. Hence, their routes have to lie at lower altitudes. Dusting the stratosphere with rather harmless salts of many-valence metals, fluorides for example, may prove useful: they prevent the formation of gas hydrates and destroy them. If the situation becomes critical, a system of lasers, which could be borne by satellites, will have to be deployed.

But what is meant by "critical"? Destruction of the ozone layer leads to cooling of the upper atmospheric layers, because there's nothing to check hard solar radiation. This further speeds up the formation of hydrates, and hence ozone decay. There possibly exists a threshold beyond which the process becomes more like an avalanche.

These are only suppositions, but they are not ungrounded. This is why the authors of this hypothesis believe it should be proved experimentally without delay. (APN)

#### Earthquake Precursor Phenomena Detected by Means of Cosmic Rays

18650185a Frunze SOVETSKAYA KIRGIZIYA  
in Russian 3 May 89 p 4

[Article by I. Libin, senior science associate of the USSR Academy of Sciences' Institute of Earth Magnetism, the Ionosphere and the Propagation of Radio Waves, and M. Tsebelev, senior science associate of the Kirgiz Academy of Sciences' Institute of Seismology]

[Excerpt] Imagine an instrument which is placed deep beneath the surface of the earth and continuously records the flow of cosmic rays over a period of many years. As a result of deformations which precede earthquakes, the mass of the matter which is located above the underground instrument will slowly begin to change, and these changes will be recorded only in underground observations. For the purpose of finding earthquake precursor phenomena with the aid of cosmic rays, a laboratory has been equipped deep underground in a gallery of the Ala-Archa observatory of the Kirgiz Academy of Sciences' Institute of Seismology. This laboratory is outfitted with modern cosmophysical instruments, including a cosmic-ray telescope based on large plastic scintillators which record cosmic radiation coming from different directions—radiation that has passed through hundreds of meters of ground. Theoretical and experimental research has been conducted for the purpose of studying mechanisms of changes in the distributions of cosmic-ray flows, with the aim of finding out how they interact with rocks of the Earth.

Physicists of the USSR Academy of Sciences' Institute of Earth Magnetism, the Ionosphere and the Propagation of Radio Waves and of the academy's Physics Institute, geologists of the Moscow Geological Surveying Institute, seismologists of the Kirgiz Academy of Sciences' Institute of Seismology and meteorologists of the Lithuanian Administration for Hydrometeorology and Protection of the Natural Environment have been taking part in this work. Preliminary studies conducted by this interdisciplinary group have shown that even changes of only 0.1 percent in the condition of rocks can be identified quite reliably with the aid of cosmic rays.

Cosmophysical seismology is in the initial stage of development at present; the first steps have been taken, but results are not always well-defined, unfortunately. Material of unquestioned interest to physicists nevertheless has already been obtained by means of new cosmophysical methods.

#### Optical Instruments Developed for Spacecraft-Aided Ocean Studies

18650185c Tallinn SOVETSKAYA ESTONIYA  
in Russian 11 May 89 p 3

[Article by R. Pels]

[Excerpt] Development of optical instruments is a sideline for Leonardo Laesson, head of the patent information department of the Estonian Academy of Sciences' Institute of Thermal Physics and Electrophysics.

"Pictures which artificial Earth satellites take of the earth's surface from space turn out to be distorted, because they are affected by all kinds of atmospheric interference," related the designer. "Physicists can calculate distortion of the earth's true image theoretically, with the aid of formulas whose constants must be checked. Photographing from scientific research vessels therefore proceeds simultaneously with picture-taking from space. A 'clean picture' is obtained as a result. Data which we have obtained in a small square can then be transferred to a space photograph of larger scale."

While floating on the surface of the sea, an instrument called "TELE", which was built at the thermal-physics institute, simultaneously measures radiation coming from the sea and illumination of the water from above in eight frequency bands. Actual radiation can be determined as a result, as can biological and other parameters of the sea's surface waters.

Exactly a year ago, in March-April of 1988, Leonardo Laesson took part in research of surface waters off the coast of Cuba, using an instrument called "LIKI". These studies were conducted under the direction of scientists of the USSR Academy of Sciences' Institute of Oceanology. The scientist tested the "TELE" instrument during an expedition which has just been completed. This expedition took place near the Vietnamese resort city of Nhatrang, 500 kilometers north of Ho Chi Minh City. Characteristics of the sea (currents, temperatures, condition of flora and fauna, etc.) obtained in the course of the research have been turned over to these countries for use in their economies.

"Temperature characteristics of the sea which were obtained in the infrared frequency range are thus important for fishermen, since it is in warm waters rich in algae and other nutrients that schools of various kinds of fish gather," explained L. Laesson.

No sooner did the latest expedition end than participants of it began a new stage of work in line with the "Interkosmos" program on April 27, at a survey area in the Gulf of Gdansk, off the coast of Poland.

UDC 551.501

**Analytical Model of Polydisperse Backscattering Coefficient for Problems in Laser Diagnosis of Atmospheric Aerosol**

18650114 Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: FIZIKA, ASTRONOMIYA in Russian Vol 30 No 1, Jan-Feb 89 (manuscript received 9 Apr 87) pp 67-70

[Article by V. L. Boychenko, T. B. Razumikhina, V. I. Rozhdestvenskaya and A. I. Kholodnykh, Department of General Physics and Wave Processes, Moscow University]

[Abstract] Difficulties arise in use of laser diagnosis for monitoring atmospheric pollutants due to the lack of acceptable methods for the processing of a laser signal at

a real time scale. Well-known methods for inversion of sounding results, based on computations by the precise Mie formulas, such as statistical regularization or interpolation methods, cannot be used because in order to obtain stable and physically reasonable solutions they require very precise measurements of optical parameters. In order to solve this problem an approximate analytical expression is derived which makes it possible to compute the polydisperse backscattering coefficients with an error not exceeding 10% for a broad range of change of parameters of the scattering particles. The use of the proposed expression, together with an analytical expression for the polydisperse volumetric scattering coefficient, makes it possible to dispense with a priori information on change in the lidar ratio along the sounding path, which results in a decrease in uncertainty in estimating the parameters of atmospheric aerosol. Figures 3; references 7: 6 Russian, 1 Western.

UDC 551.501.7-543.422.4

**Continuous Monitoring of Atmospheric Ammonia Content at Chemical Plant Using 'Trassa' Laser Long-Path Gas Analyzer**

18650146 Tomsk OPTIKA ATMOSFERY in Russian Vol 1 No 12, Dec 88 (manuscript received 1 Aug 88) pp 42-46

[Article by E. V. Anufriyev, V. P. Biryulin, A. K. Koval, V. D. Mironov, Yu. G. Putilov and S. N. Tsybenko, Moscow Physical Engineering Institute]

[Abstract] The design of the "Trassa" laser long-path differential absorption gas analyzer is described. The instrument is intended for continuous determination of the content of a number of pollutant gases at industrial plants. A block diagram of this analyzer, whose principal component is a tunable CO<sub>2</sub> laser, operating in a two-wave mode, with 22 components identified, is given and serves as a basis for a detailed textual description. The outfit has an external optical circuit with matched receiving-transmitting telescope and retroreflector. Data processing and control units are incorporated, the latter based on the AFC principle. The functions of switching and power equalization of working and reference lines are combined. Design and operation are simple; the total collection of radiation is ensured and the influence of the state of the atmosphere on the measurement result is reduced; the overall dimensions of the optical elements have been minimized; the necessary laser radiation output power and power consumption are low and safe operating conditions are ensured; the use of uncooled photodetectors is possible. Instruments of this type are promising for use in both work rooms and in open industrial areas. Use of the instrument is illustrated by ammonia measurements at an industrial plant. The systematic error was 0.15 mg/m<sup>3</sup> for a path length 20 m, whereas the random error was 0.02 mg/m<sup>3</sup>. Figures 4; references 12: 10 Russian, 2 Western.

UDC 551.510.04

**Three-Dimensional Mesoscale Model of Transport of Anthropogenic and Cloud Aerosol With Allowance for Interaction Between Radiation and Microphysical Processes and Orography. Part I. Formulation of Problem**

18650159a Tomsk *OPTIKA ATMOSFERA* in Russian  
Vol 2 No 2, Feb 89 (manuscript received  
3 Aug 88) pp 115-121

[Article by K. Ya. Kondratyev, V. G. Bondarenko and V. I. Khvorostyanov, Central Aerological Observatory, Dolgoprudny]

[Abstract] In earlier studies three-dimensional models of clouds over the land and ocean were constructed with allowance for evolution of optical parameters during interaction of microphysical and radiation processes, including with the presence of crystals, but neglecting orography, although in many cases it exerts a considerable influence on the optical properties of clouds and the transport of aerosol. A new three-dimensional nonstationary mesoscale model has been constructed for clouds, fogs and transport of admixtures in an orographically inhomogeneous atmospheric boundary layer. This model makes it possible to investigate the influence of interacting cloud cover and aerosol on the radiation regime of the atmosphere and underlying surface, the influence of orography on the microphysical and optical characteristics of cloud cover and the patterns of transport of anthropogenic aerosol. Use of such a numerical model is important for understanding cloud-radiation relationships and their influence on the optical properties of the atmosphere and the formation of microclimate in industrial and urbanized regions. The numerical computations can considerably facilitate the formulation of time-consuming and expensive experiments for remote sensing of atmospheric optical parameters, as well as investigations of environmental pollution. [Some results of application of this model are given in the second part of this research, published in the same number of this journal, pages 122-132.]

UDC 551.510.04

**Three-Dimensional Mesoscale Model of Transport of Anthropogenic and Cloud Aerosol With Allowance for Interaction Between Radiation and Microphysical Processes and Orography. Part II. Results of Computations**

18650159b Tomsk *OPTIKA ATMOSFERA* in Russian  
Vol 2 No 2, Feb 89 (manuscript received  
3 Aug 88) pp 122-132

[Article by K. Ya. Kondratyev, V. G. Bondarenko and V. I. Khvorostyanov, Central Aerological Observatory, Dolgoprudny]

[Abstract] The model used in this research was described in the first part of this paper, published in the same number of this journal, pp 115-121. Three series of

numerical experiments were carried out. In the first series a study was made of the influence of orography on the mesostructure of clouds and fogs, optical-aerosol relationships and the propagation of aerosol, interacting with condensate fields. The second series was devoted to a study of the influence of the slope of model relief on the propagation of aerosols from surface and uplifted point and vertically extended sources. In the third series the transport of aerosols and their sedimentation onto a flat underlying surface from such sources was simulated. As demonstrated by these experiments, the model satisfactory describes cloud-radiation and optical-aerosol relationships at a mesometeorological scale in an orographically inhomogeneous atmospheric boundary layer. Estimates were made of the influence of orographic inhomogeneities of the underlying surface on the formation of fogs and cloud cover; their influence on restructuring of the radiation regime in the entire atmospheric boundary layer was investigated; the patterns of propagation of aerosol particles with different weight characteristics were studied for different types of stable temperature stratification, determined by the interrelationship between clouds and radiation. In regions of anthropogenic pollution and orographic inhomogeneity of the underlying surface, as in cities, the distribution of cloud cover and aerosol may differ substantially from the mean statistical optical-aerosol and cloud-radiation models. Among the many possible applications of the model is research on the influence of cities on the optical characteristics of the atmosphere and microclimate, in optical monitoring of pollutants and in remote sensing of the atmosphere in industrial regions. Figures 5; references 21: 14 Russian, 7 Western.

UDC 535.21:538.97

**Millisecond Kinoholography of Collective Optical Discharge**

18650159c Tomsk *OPTIKA ATMOSFERA* in Russian  
Vol 2 No 2, Feb 89 (manuscript received  
9 Aug 88) pp 180-187

[Article by Yu. N. Zakharov and Yu. M. Sorokin, Gorkiy State University imeni N. I. Lobachevskiy]

[Abstract] An outfit for the registry of four-frame multiplex holograms of a collective optical discharge (COD) is described which is based on independent optical sources and electronic delay lines operating in a wide time interval (until now the parameters of a COD have been studied largely by the shadow method, which while effective in studying the front, supplies little information on the structure of the discharge nucleus). The alternative to the shadow method is kinoholography, but existing schemes do not cover the range of time scales necessary for description of such a long-lived phenomenon as a COD. The proposed outfit remedies these earlier shortcomings, providing good information on the structure and dynamics of the COD nucleus. A block diagram of the apparatus employed is given, accompanied by a detailed description. For the first time it was



possible to register an effect of COD propagation in aerosol having a jumplike or "relay race" character. In the latter case the COD lifetime is increased due to a lag in evolution of secondary nuclei relative to the primary nucleus. An algorithm, based on a COD threshold model, was used in retrieving the temperature and electron concentration profiles in the discharge. Figures 4; references 19: 18 Russian, 1 Western.

UDC 551.511.33

**Parametrization of Dynamic and Thermal Effect of Steady Internal Gravity Waves on Middle Atmosphere**

18650129a Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 25 No 3, Mar 89 (manuscript received 25 Mar 88) pp 271-278

[Article by N. M. Gavrilov, Leningrad State University]

[Abstract] Several parametrizations of wave accelerations of the mean flow have been published for internal gravity waves (IGW) attaining a steady mode when the amplitude and wave energy do not change with time. However, these parametrizations are inadequate because it is usually assumed that the IGW are saturated and amplitude is invariable with altitude. However only IGW with small vertical wave lengths attain saturation; for longer waves the amplitudes change. Existing parametrizations do not make full allowance for the return influence of circulation and temperature inhomogeneities on the propagation and variation of IGW. These shortcomings have been rectified in the proposed parametrization for computing the accelerations of mean movement and heat inflows generated by IGW in the middle atmosphere. The vertical coefficients of turbulent and molecular dissipation, resulting in the damping of wave energy, are assumed to be known. Model computations confirming the suitability of this parametrization for inclusion in numerical schemes of general circulation of the middle atmosphere are presented. Figures 2; references 17: 11 Russian, 6 Western.

UDC 551.501.793

**Experiment With Comparison of Apparatus for Measuring Turbulent Transport of CO<sub>2</sub>**

18650129b Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 25 No 3, Mar 89 (manuscript received 16 Feb 88) pp 279-285

[Article by Yu. A. Volkov, L. G. Yelagina, E. Ohtaki and O. Tsukamoto, Atmospheric Physics Institute, USSR Academy of Sciences; Okayama University, Japan]

[Abstract] Joint work for the comparison of instruments for measuring turbulent transport of carbon dioxide developed at Okayama University in Japan and at the Atmospheric Physics Institute in the USSR was carried

out in July-August 1987 near Zvenigorod. Both instrument complexes are described. The frequency spectra of turbulent fluctuations of CO<sub>2</sub> measured by the two groups have an identical form which in the high-frequency region corresponds to the Kolmogorov-Obukhov "5/3" law. There was a good agreement between the dispersions of CO<sub>2</sub> and the vertical turbulent fluxes of carbon dioxide and the spectra of these fluxes were in good agreement. The vertical turbulent fluxes of carbon dioxide were measured over mown grass and plowed fields. The successful experiment yielded close results even in a case when the CO<sub>2</sub> fluxes were extremely small and photosynthesis was virtually absent. Figures 6; references 7: 5 Russian, 2 Western.

UDC 551.510.42

**Research on Microstructure and Chemical Composition of Stratospheric Aerosols**

18650129c Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 25 No 3, Mar 89 (manuscript received 14 Dec 87, after revision 18 Apr 88) pp 293-301

[Article by L. S. Ivlev, V. M. Zhukov, V. I. Kudryashov and S. N. Pogorskiy, Leningrad State University]

[Abstract] The results of balloon and rocket impactor measurements of the structure and chemical composition of stratospheric aerosols are given for the period 1980-1985. The research was done by specialists at the Aerosol Physics Laboratory, Leningrad State University. The observation period included three significantly different situations: before the Chichon eruption; period of eruption and strong change in stratospheric state; period of return of stratosphere to stationary background state. In the autumn of 1982 the eruption gave rise to the appearance of an aerosol layer at about 30 km where the homogeneous formation of sulfuric acid droplets occurred. This layer persisted in 1983 and only in 1984 was there an appreciable decrease in the particle concentration at altitudes greater than 25 km and a decrease in the altitude of the main aerosol layer. The strong changes in structure and chemical composition of the aerosol particles observed during this period are reviewed. The cluster hypothesis of the formation of stratospheric aerosols is examined and it is shown that there is a complex dependence between different mechanisms of the generation of nuclei and nucleation processes. Figures 5; references 16: 7 Russian, 9 Western.

UDC 551.510.534

**Method for Constructing Empirical Model of Vertical Distribution of Ozone**

18650129d Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 25 No 3, Mar 89 (manuscript received 14 Apr 88) pp 302-306

[Article by V. I. Bekoryukov, Central Aerological Observatory]

[Abstract] There have been no azonal models of ozone density for the lower stratosphere. This is attributable to

the the great lack of experimental data. Only ozonsonde measurements are suitable for constructing such a model and there are only 18 regularly operating, nonuniformly spaced ozone sounding stations in the northern hemisphere. The only possibility for constructing such a model is use of the close correlation between total ozone content and ozone density in the lower stratosphere. The problem was solved using the climatic model of total ozone content developed earlier by the author (METEOROLOGIYA I GIDROLOGIYA, No 4, pp 53-60, 1986). It is sufficient that the profile of the vertical distribution of ozone (VDO) constructed on the basis of ozonsonde data at any station be transferred to points with those coordinates where the line of equal content of ozone for a particular month, corresponding to the one station, intersects with the latitude of the other station. The procedure for constructing an azonal model from this approach is outlined and illustrated for a January situation. There was a satisfactory agreement between the maps constructed on the basis of satellite data and that plotted using the azonal model. This application of the high correlation between total ozone content and ozone density in no way can be considered correct for the troposphere, for which the construction of only a zonal model is possible. Figures 3; references 10: 6 Russian, 4 Western.

UDC 551.464.34

#### **Estimation of CO<sub>2</sub> Flux Between Atmosphere and Atlantic Ocean**

18650129f Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 25 No 3, Mar 89 (manuscript received 29 Oct 87, after revision 15 Feb 88) pp 333-334

[Article by A. Kh. Degterev, Marine Hydrophysics Institute, Ukrainian Academy of Sciences]

[Abstract] Due to the small number of instrumental measurements of CO<sub>2</sub> in the ocean, pH and alkalinity data are used in computing the resultant CO<sub>2</sub> flux between the ocean and the atmosphere. For the Atlantic Ocean different sources have given widely varying values, in part due to the great variability of CO<sub>2</sub> partial pressure at the Atlantic Ocean surface. Due to nonuniformity of study of the pH field, this results in considerable averaging errors. Computations of the partial pressure field on the basis of averaged pH values also introduces a systematic error, which is estimated in this article. For the Atlantic Ocean the preaveraged pH values result in an exaggeration of the resultant flux by  $1.1 \times 10^9$  tons C/year. Use of materials in the "Okeanografiya" data bank makes it possible to compute the partial pressure at each station and thereby to avoid the systematic averaging error (the computation method was described by A. Kh. Degtyarev, et al. in METEOROLOGIYA I GIDROLOGIYA, No 5, pp 62-69, 1986). According to more than 12 000 pH measurements, the global CO<sub>2</sub> flux into the Atlantic Ocean is  $0.35 \times 10^9$  tons C/year, indicating a closeness of the CO<sub>2</sub>

field at the ocean surface to a state of dynamic equilibrium with the atmosphere. The resultant CO<sub>2</sub> flux between the ocean and the atmosphere is also estimated. Assuming the CO<sub>2</sub> flux into the Atlantic to be proportional to its area (23%), the value obtained is  $0.51 \times 10^9$  tonsC/year. References 9: 6 Russian, 3 Western.

UDC 551.510.41

#### **Lidar Measurements of Vertical Density and Temperature Profiles in Middle Atmosphere**

18650151 Ashkhabad IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR in Russian No 1, Jan-Feb 89 (manuscript received 10 May 88) pp 9-12

[Article by O. G. Ovezgeldyyev, Kh. Mamedov, K. Melekayev and V. G. Khamidulina, Physical Technical Institute, Turkmen Academy of Sciences]

[Abstract] Measurements of the vertical profiles of stratomesospheric (30-65 km) density and temperature were made at the Physical Technical Institute, Turkmen Academy of Sciences. The lidar sounding experiment involved measurement of the backscattering signals caused by molecular scattering of the sounding pulse. It was assumed that with the normal content of aerosol above 30 km the aerosol attenuation and Rayleigh scattering coefficients decrease proportionally to altitude. The aerosol attenuation coefficient is only about 15% of the Rayleigh scattering coefficient and the influence of aerosol can be neglected other than in cases of extremal turbidity of the upper atmosphere. The sounding signal is therefore a linear function of density of the neutral atmosphere. For absolute density measurements it is necessary of have radiosonde data obtained simultaneously with lidar measurements made in the same place. The temperature profile is computed from the density profile on the assumption that at altitudes greater than 30 km the atmosphere conforms to gas laws and is in hydrostatic equilibrium (turbulence exerts no influence on density). A comparison of lidar and rocket measurements gave good agreement in the range  $\pm 2^\circ$  in the altitude range 30-50 km. The results of lidar measurements are given with standard deviation data. The deviations of computed temperatures from the model were within the limits of temperature variations in the real atmosphere. Figures 2; references 7: 5 Russian, 2 Western.

UDC 551.511.3

#### **Distribution of Temperature Field Structural Characteristic in Near-Water Atmospheric Layer**

18650156 Baku DOKLADY AKADEMII NAUK AZERBAJDZHANSKOY SSR in Russian Vol 44 No 10, Oct 88 (manuscript received 10 Feb 88) pp 40-43

[Article by A. S. Aliyev, Space Research Scientific Production Association]

[Abstract] The structural characteristic of the temperature field  $C^2_T$  is the principal parameter characterizing the intensity of turbulent fluctuations of air temperature



in the range of scales from several millimeters to several meters. This structural characteristic is incorporated in the Obukhov "-5/3" law for the spectra of temperature fluctuations. This parameter must be known in order to predict the noise accompanying the propagation of optical waves in the atmosphere over a sea surface. At present there is no systematic information on the possible distribution of this parameter. The absolute values of this parameter were obtained during the summer and autumn of 1978-1979 over the Caspian Sea from a fixed base with measurements at heights 8-10 m above the calm sea surface. The parameter was determined from spectra of temperature fluctuations at 3 Hz. Data are given for three different months, with a comparison with data from other authors. A table gives the meteorological conditions prevailing during the measurements. The maximal values were in September and the minimal values in November. The data are consistent with the results of research elsewhere in the world ocean and it is concluded that the data are characteristic for the mentioned period in the near-water layer of the atmosphere. Figure 1; references 5: 4 Russian, 1 Western.

UDC 551.510.535

**Vertical Distribution of Water Vapor Determined From Direct Measurements by Balloon-Borne Fluorescent Optical Hygrometer**

18650139a Tomsk OPTIKA ATMOSFERA in Russian  
Vol 1 No 12, Dec 88 (manuscript received  
8 Aug 88) pp 26-28

[Article by M. V. Kretova, M. G. Khaplanov and V. A. Yushkov, Central Aerological Observatory, Dolgoprudnyy]

[Abstract] An instrument package which included an optical fluorescent hygrometer was developed at the Central Aerological Observatory for carrying out direct measurements of composition of the ozonosphere. The operating principle is based on measurement of fluorescence intensity (in the spectral range 306-316 nm) of molecules of excited hydroxyl, which are formed as a result of dissociation of water molecules under the influence of vacuum UV radiation with a wavelength shorter than 137 nm. The vacuum UV source and the photodetector are situated in the same plane at an angle of 60° to one another. The source of UV is a Kr R-2-2 lamp giving emission of the resonance line of krypton at 123.6 nm. The photodetector includes a narrow-band interference light filter and a photomultiplier. The procedures for hygrometer calibration are given in detail. In the described experiment balloon drift lasted about 15 minutes. Instrument readings coincided during balloon ascent and descent, indicating correctness of measurement of water vapor concentration by the balloon-borne instrument. In the range of altitudes 15-21 km the mixing ratio of water vapor varied from 6 to 15 ppmv and increased to 20 ppmv at 27.5 km. Figures 2; references: 2 Western.

UDC 535.375.5

**Laser Diagnosis of Heterophase Water Objects**

18650139c Tomsk OPTIKA ATMOSFERA in Russian  
Vol 1 No 12, Dec 88 (manuscript received  
17 Aug 88) pp 80-86

[Article by S. M. Glushkov, I. M. Panchishin and V. V. Fadeyev, Moscow State University imeni M. V. Lomonosov]

[Abstract] A study was made of systems containing water simultaneously in the liquid and solid phases by the Raman spectroscopy method. This required a detailed investigation of the behavior of Raman scattering spectra of each phase state both near the phase transition point and distant from it to the right and left on the temperature scale. The Raman scattering spectra of water and ice differ greatly from one another, making possible an analysis of heterophase systems on the basis of the shape of the Raman scattering valence band. The source used for exciting the spectra was an LG-106M-1 argon laser with an excitation wavelength 488 nm. The spectra were registered by an optical multichannel analyzer connected to a microcomputer. The RS spectra for liquid water and ice were registered in the temperature ranges 65...-7.5°C and 0...-146°C. The dependence of water and ice spectra on temperature was analyzed; a method is given for determining the partial concentrations of H<sub>2</sub>O molecules in a mixture of the liquid and solid phases; applicability of the Fourier deconvolution method is examined and the procedures for determining organic impurities in snow are outlined. Figures 3; references 9: 7 Russian, 2 Western.

UDC 551.501.7

**Comparative Measurements of Temperature and Wind Speed Using Radioacoustic Sounding Outfit and High Meteorological Mast**

18650139b Tomsk OPTIKA ATMOSFERA in Russian  
Vol 1 No 12, Dec 88 (manuscript received  
1 Aug 88) pp 69-75

[Article by B. S. Yurchak, Experimental Meteorology Institute, Tayfun Scientific Production Association]

[Abstract] Despite satisfactory theoretical validation of the method, in the practical introduction of any radioacoustic sounding system it is always essential to ascertain its real accuracy characteristics. Specific details are given on the joint measurement of temperature and wind speed carried out in the spring and autumn of 1987 using the RAL-17 sounder (operating at 17 cm). The RAL-17 is described in detail, followed by comparative measurements of temperature and mean wind speed for a layer obtained using this outfit and data from the 300-m high meteorological mast at the Experimental Meteorology Institute. The RAL-17 consists of an acoustic channel, a continuous Doppler radar and a measuring and registry channel (a block diagram of the apparatus is given and

its technical specifications are listed). The discrepancies between temperatures registered by the sounder and on the high mast were in the range plus or minus  $0.5^{\circ}\text{C}$  and a close, satisfactory agreement was also obtained for wind speed. The results, illustrated in a series of figures, confirm the possibility of estimating the mean wind speed in a layer from the amplitude-temporal characteristics of a radioacoustic echo signal. Figures 4; references: 7 Russian.

UDC 551.521.3:535.36

**Method for Computing Image Brightness With Allowance for Anisotropy and Inhomogeneity of Underlying Surface**

18650139d Tomsk OPTIKA ATMOSFERY in Russian  
Vol 1 No 12, Dec 88 (manuscript received  
25 Jul 88) pp 94-101

[Article by I. V. Mishin, All-Union Scientific-Technical Information Center, Moscow]

[Abstract] A method is proposed for simulating an aerospace image with extremely general assumptions concerning the brightness coefficients of the underlying surface. The method is based on use of solutions of boundary-value problems in transfer theory in a plane-parallel atmosphere. The approach makes possible a joint allowance for anisotropy and spatial inhomogeneity of reflection of the Earth's surface both in solution of the direct problem of computing the brightness field of outgoing radiation and in solving the inverse problem of retrieving the law of reflection by the Earth's surface on the basis of data from satellite measurements. Algorithms are written which make it possible, on the basis of a stipulated distribution of the reflection indicatrices and albedo of the underlying surface, to form the brightness field at the input of a passive optical observation system and also to restore the albedo function from a space image with a stipulated dependence of the surface brightness coefficient on angle. The solutions generalize known relations for isotropic reflection from the underlying surface and are more effective with respect to numerical application than any obtained earlier. In order to reduce the errors associated with inadequacy of the used atmospheric model it is necessary to have data on state of the atmosphere at the time of an experiment. References 16: 12 Russian, 4 Western.

UDC 551.513.1

**Description of Large-Scale Movements in Middle Atmosphere and Rossby Waves in Convection Theory Approximation**

18650169a Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 25 No 4, Apr 89 (manuscript received 25 Apr 86,  
after revision 17 May 88) pp 356-366

[Article by A. N. Vulfson, USSR Hydrometeorological Center]

[Abstract] By averaging the primitive equations of hydrothermodynamics for the thickness of the troposphere and making other simplifications related to linearization of the thermodynamic parameters and performing filtering of fast gravity waves it is possible to

derive a system of equations almost identical to the system of equations for the theory of convection, in which the background temperature gradient is determined by the temperature difference between the equator and the pole. This system of equations can be regarded as a connecting link in a series of successive simplifications for conversion from the primitive equations of hydrothermodynamics to very simple systems of the hydrodynamic type. A linear analysis of this system makes it possible to discriminate two families of wave movements: fast barotropic waves and thermal Rossby waves. These equations make it possible to detect a decrease in the velocity of propagation of Rossby waves in the troposphere (averaging 20) and to discriminate a special type of quite short waves associated with horizontal temperature stratification whose velocity relative to the zonal flow is equal to half the velocity of a classical Rossby wave. Using the proposed equations it is shown that an instability of the convective type can form in a homogeneous zonal flow. The necessary and adequate condition for this instability is the Rayleigh condition, substantially modified due to the  $\beta$  effect. The existence of thermal stratification between the equator and the pole exerts a significant influence on the structure of west-east transport and phase velocity of Rossby waves and the relative phase velocity of quite short waves is reduced by half. Solutions are given for nonlinear equations corresponding to stationary systems of cyclones and anticyclones moving against the zonal flow. References 16: 15 Russian, 1 Western.

UDC 551.521.32

**Comparison of Measured and Computed Transmission Functions of  $\text{O}_3$  Absorption Band at  $9.6\mu\text{m}$**

18650169b Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 25 No 4, Apr 89 (manuscript received 29 Oct 87,  
after revision 17 Mar 88) pp 374-379

[Article by Yu. M. Timofeyev, A. N. Trotsenko and B. A. Fomin, Leningrad State University]

[Abstract] The parameters of the molecular absorption band of  $\text{O}_3$  at  $9.6\mu\text{m}$  are analyzed after a comparison of laboratory studies of the transmission function for this band (Bartman, et al.) and direct computations based on two versions of a magnetic tape with data on fine structure registered by McClatchey and Rothman. It was found that the version of 1980 has a higher quality of the fine structure of the band than the version of 1976. The use of version 2 makes it possible to reduce the  $\Delta(\gamma)$  and  $\sigma(\gamma)$  values by a factor of 1.5-2, but even for version 2 the  $\Delta(\gamma)$  and especially the  $\sigma(\gamma)$  values exceed the experimental errors, indicating a need for further correction of the fine structure parameters, especially on the basis of special laboratory measurements with a high spectral resolution. Correction of the mean half-widths of the

spectral lines resulted in a considerable decrease in the  $\Delta(\gamma)$  and  $\sigma(\gamma)$  values only in the spectral region 9.35-9.55  $\mu\text{m}$ . It was found that the mean value of the line half-width in the band  $\alpha_0 = 0.85 \text{ cm}^{-1} \times \text{atm}^{-1}$  is more justified than the value  $\alpha_0 = 0.110 \text{ cm}^{-1} \times \text{atm}^{-1}$  used in both versions. The integral transfer functions agree within the limits 1-2%. Figures 2; references 20: 11 Russian, 9 Western.

UDC 551.521.31

**Accuracy in Determining Atmospheric Optical Thickness at Given Moment in Time**

18650169c Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 25 No 4, Apr 89 (manuscript received 11 Jun 87,  
after revision 13 Jun 88) pp 380-386

[Article by V. N. Glushko, L. A. Yegorova, P. G. Lysenko and Ya. A. Teyfel, Astrophysics Institute, Kazakh Academy of Sciences]

[Abstract] A knowledge of the real value of the spectral optical thickness of atmospheric extinction  $\tau_\gamma$  at a specific moment in time is essential in making allowance for influence of the atmosphere on the results of remote sensing of the surface from space. The  $\tau_\gamma$  parameter, determined from the surface at the time of spacecraft transit over a subsatellite region, can serve as a test in checking methods for making allowance for the atmosphere as a scattering and absorbing medium. The real accuracy in determining this parameter has not been given due attention. A study was therefore made to ascertain the accuracy in determining  $\tau_\gamma$  in the wavelength range 0.4-2.24  $\mu\text{m}$ . An empirical formula is derived for computing the error of this parameter as a function of atmospheric mass and wavelength. Estimates of the errors are made for specific atmospheric-optical situations characterizing the entire ensemble of experimental data. The relative errors in determining  $\tau_\gamma$  may vary from a few to hundreds of percent. Figures 2; references 11: 10 Russian, 1 Western.

UDC 551.466.3

**Formation of Narrow Angular Spectrum of Wind Waves With Nonlinear Interaction Between Waves and Wind**

18650169e Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 25 No 4, Apr 89 (manuscript received  
9 Mar 88) pp 411-420

[Article by L. Sh. Tsimring, Applied Physics Institute, USSR Academy of Sciences]

[Abstract] Induced scattering of waves on particles can result in the formation of narrow spectra of waves in k-space (the interaction between surface waves and the wind has the same resonance character as the interaction between plasma waves and particles). In earlier studies

(IZV. AN SSSR: FAO, Vol 19, No 1, pp 68-73, 1983; METEOROLOGIYA I GIDROLOGIYA, No 11, pp 76-81, 1986), within the framework of a quasilinear model, a kinetic equation was derived for waves which takes into account processes of nonlinear interaction with the wind. This equation reveals that in contrast to linear Miles instability processes of the induced scattering type can be important in the energy-bearing range of wind waves. However, in the earlier studies the author examined only a one-dimensional case when all the waves are propagated along the wind and therefore the kinetic equation derived there cannot be used for describing the evolution of the angular spectrum of wind waves. Proceeding along these lines, a new kinetic equation is derived for a two-dimensional case in Section 2; an analysis of this equation is given in Section 3 for a case when the spectrum is already quite narrow in k-space. In such a "small-angle" approximation the kinetic equation is considerably simplified, which analytically makes it possible to find the law of narrowing of the spectrum and numerically compute the form of the self-similar angular spectrum. Section 4 deals with the formation of a stationary angular spectrum under the joint influence of the induced scattering of waves by the wind and nonlinear four-wave interaction. Figures 5; references 13: 10 Russian, 3 Western.

UDC 551.510.42

**Stationary Model of Planetary Distribution of Aerosol Particles in Upper Atmosphere**

18650169f Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 25 No 4, Apr 89 (manuscript received  
14 Mar 88) pp 439-441

[Article by G. M. Teptin and L. V. Morozova, Kazan State University]

[Abstract] The authors published a stationary model of suspended particles in the atmosphere in IZV. AN SSSR: FAO, Vol 18, No 7, pp 697-704, 1982. This model has now been used in solving the problem of the seasonal and latitudinal-longitudinal distribution of aerosol particles in the upper atmosphere for the northern hemisphere. The initial data for computing the concentration of aerosol particles in the model were the parameters of turbulence, rate of settling, density of aerosol particles and size distribution of aerosol particles. The thermodynamic parameters of the atmosphere were taken from the Four-D Global Reference Atmosphere. The temperature, pressure and density values were determined each 10° in longitude for latitudes 10, 30, 50, 70° for 12 months; then the total concentration of aerosol particles was computed at the altitude levels 70, 80 and 90 km. Hemisphere maps on which the isolines of concentration of aerosol particles are plotted were compiled, from which a series of conclusions was drawn. For example, the change in concentration of aerosol particles from season to season and in longitude and latitude is most

clearly expressed at 70 km, decreasing to an altitude of 90 km. Seasonal variations are most clearly expressed in the northerly latitudes. On the average, for altitudes 70 and 80 km at northerly latitudes the concentration in summer is twice as great as in regions close to the equator. The annual maximum of concentration of aerosol particles at all altitude levels in summer is in the northerly and middle latitudes; in the southerly latitudes there is a difference in the seasonal-latitudinal curve for altitudes 70, 80 and 90 km. Whereas for the first two the

concentration is maximal in summer and minimal in winter, at 90 km at latitudes 10°N and 30°N there is a maximum in October and a minimum at 10°N in March and at 30°N in July. The concentration gradient in latitude has a maximal value for altitudes 70 and 80 km in July and 90 km in January. The variations in concentration of aerosol particles are shown to be related to the annual change in thermodynamic parameters at the considered altitudes. Figures 3; references 3: 2 Russian, 1 Western.



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